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Complex Suspension Rheology Using High Performance Computing

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In processing advanced ceramic materials, the properties of the final product depend on the process conditions and the interactions between the materials at the scale of the individual particles. Along with general bulk properties, more subtle properties including particle orientation, segregation, and pore structure must be established during processing to achieve the desired functionality. Accomplishing this requires a thorough understanding of the mesoscale interactions and how they influence the macroscale behavior. We conduct a series of large scale simulations of highly filled polymer-nanoparticle composites as analogs of ceramic pastes and reveal how the ceramic particle and binder properties determine the structure and rheology of the bulk material. As with real ceramic pastes, particle shape and size distribution along with composition determine the shear modulus, extent of segregation, and degree of particle alignment. These factors are influenced by the binder through the rheology of the binder phase and the interaction between binder and particles. This talk presents the results of this study of polymer-nanoparticle composites along with a brief overview of research and development at Corning showing the similarities and differences between research in industry and academia.